LUBRICATION

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We invite correspondence from all those interested.

Those who fail to receive Lubrication promptly, will please notify us at once and will confer a favor by promptly reporting change of address.

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OIL GROOVES IN BEARINGS

Considerable comment has been developed on the article which was published in the last issue of Lubrication, entitled "Oil Grooves in Bearings," written by Mr. C. N. Scott. It is evident from the comment which has developed that this subject is of the greatest importance, and that there is some diversity of opinion upon the point. Some inquiry has been made as to the investigations and experience upon which these tests were based. It is pertinent, therefore, to follow this article with the statement that the figures and statements made in Mr. Scott's article are based upon a long and varied experience with all kinds of units of both steam and gas power, ranging from the larger units made down to the smallest sizes. Mr. Scott's experience in these matters is of such a breadth and covers so thoroughly the field that it entitles him to speak with the full weight of authority, not only from a theoretical standpoint, but from the practical results which he has obtained in his working out of every-day running of such units. Readers may be assured, therefore, that the information given in that article is based upon a practical experience of a most important kind, and the result of study which makes the conclusions thoroughly accurate.

SPECIFICATIONS

In the last issue of Lubrication we published an article on Specifications for Oil, in which the variation of certain tests was mentioned; under the head of "Fire" a typographical error was made in the figures which we are correcting herewith. The tests should read as follows:

Gravity	19° to 31° B
Flash	320° to 400°F
Fire	370° to 450°F
Cold	0° to 30° F
Viscosity (on Sayboldt instrument)	120″ to 750″
or higher at	100°

A very large group of mills in the South made a thorough test of our oils on 36 ring spinning frames, which were built by Fales & Jenks. Each frame had 272 ring spindles. The method of oiling these spindles was to fill them up every two weeks. The first test was made from January 10th to January 16th, the readings being made during six days, at which time the competitor's oil was in use in the bath spindles, in motor bearings and upon the shafting. The spindles averaged about 10,000 R.P.M., and they were spinning yarn No. 40. The power to drive the frames was furnished through a General Electric Company's Three Phase Induction Motor. The power readings were taken with a special Kilowatt meter which was cut into the circuit, and readings were taken from one to four times each day and averaged for the day.

After the test on the competitor's oil was finished, the frames were operated continuously for 23 days, during which time the bath spindles were oiled three times with Texaco Oil, the balance of the frame being oiled daily. It is assumed that practically all of the competitive oil in the spindles was eliminated by the time the last six days were taken for comparative test. All the conditions were equal, and the following table gives the average readings with the reductions in amount and per cent.—

	Former Oil	Texas Co. B. Spindle	Reduction
Average K.W.	143.0	131.16	11.84=8.2%
Average H.P.	191.6	175.8	15.8 =8.2%
Temperat'e (Outside)	33.5°	50.15°F	
Relative Humidity, (Outside)	63.5%	78.5%	

Referring to the above, it will be seen that there was quite a considerable reduction in power effected through the use of Texaco lubricants. During the test with the Texaco lubricants the temperature outside was considerably higher, at the same time the relative humidity was also higher. These two outside conditions would probably have an effect on the inside conditions of the mill, to a degree, however, not the same as indicated in the above figures. The effect of increase in temperature would be in favor of the reduction in power during the use of Texaco lubricants; the effect of the increase in humidity would be against the reduction in power. Quite probably the inside conditions were more equal than indicated by the outside readings, and it is quite probable that they would equalize to an extent that would nullify any effect upon the power one way or the other.

The power tests were made by the mill people and the figures were taken from a report which was made to the head office of the Company, and as a result of the test we have secured the entire lubrication of quite a group of mills.

During the tests above mentioned a durability test was made on another frame. The frame was prepared by cleaning out the spindles and bolsters and bases, the spindles on one side were then lubricated with competitive oil and the spindles on the other side lubricated with Texaco Oil. The frame was run for five weeks without further oiling. The spindles and bolsters were then taken out and each one examined. Close inspection developed the fact that the bolsters and spindles which were lubricated with the competitive oil showed to be somewhat dryer than were the spindles which were lubricated with Texaco Oil. Indications during this test were that the Texaco Oil had greater durability, longer wearing properties, and during the frictional test the indications were that the power was 8.2% less while operating with Texaco lubricants.

(Reprinted from New York "Herald")

LUBRICATION OF FIRST IMPORTANCE

Disordered Oiling System Will Work Great Injury to the Motor, Says Mr. Stewart.

By William H. Stewart, Jr.

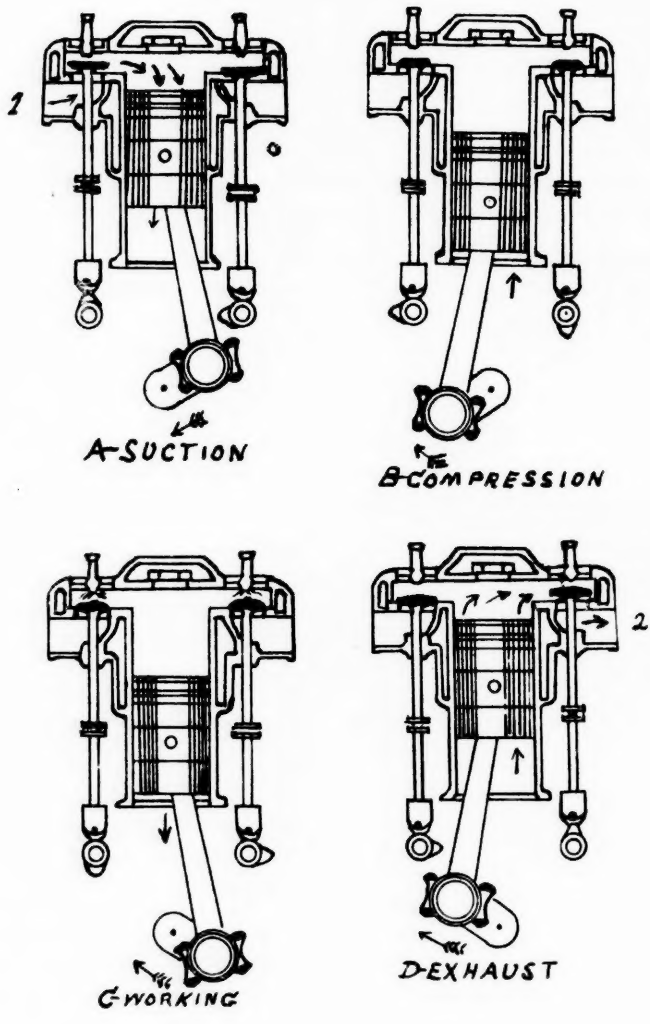
The most important feature of the automobile motor is proper lubrication. If the ignition system fails completely the motor will not run. Should the carbureter lose its adjustment, supplying no gas to the cylinders, the motor will not run. In either case no damage to the motor is experienced. However, with the oiling system out of order, supplying an insufficient amount of oil to the friction surfaces, the motor continues to run and, with very little warning the excessive friction burns out a bearing or causes the working parts to adhere and score beyond repair.

Manufacturers, realizing this important point, have designed the lubricating systems as "fool proof" as possible. Every friction surface is provided with a means for lubrication. The most indifferent operator has little more to do than keep the oil reservoir supplied and note the flow of oil through the sight gauge.

Quite often it happens that the oil pump becomes clogged and the flow of oil is stopped. In cars provided with a sight gauge this trouble can be detected when the motor is running. The oil gauge is usually placed in plain view of the dash and is part of the oil circuit. In other words, the oil in flowing to its work must pass through the sight gauge and before the eye of the operator.

As different makes of automobiles employ different systems for forcing the oil about the engine, one should note in detail the instructions from the manufacturer. A great many systems have no adjustment of the flow. In such instances there is a single sight feed on the dash and a constant level maintained in the crank case. Other systems have several sight feeds, with adjustments, and these lead to various parts of the motor. When once adjusted these sight feeds very rarely get out of order. However, it is quite often necessary to readjust them when another grade of oil is used. The number of drops a minute may readily be determined with the engine running normally and with the aid of a watch.

Regarding the grade of oil to use in a motor, it is enough to say that the best grade obtainable is cheap in the long run. A great many owners attempt to economize in oil. But the few cents saved is later expended for labor in cleaning out excessive carbon and constant grinding of the valves. The man who purchases an automobile should be prepared to give it proper lubrication, as cheap oil and grease will do more to depreciate the value of an automobile than actual service.



A Four Cycle Motor in Operation

MOTOR LUBRICATION WITH SOME SIDE LIGHTS ON COMPRESSION AND CARBON

In order to understand fully the requirements of motor lubrication and some of the conditions which occur in the cylinders of an explosion motor during their various operations, the opposite sketch is introduced showing sections of a single cylinder and valves, with the piston in the four positions representing the four different cycles or strokes through which it is necessary to operate to derive the power from the motor.

These four sections show the taking in of the explosive mixture, compressing it, exploding it and exhausting it. In the description below of the various stages in the operation of the explosion motor, full consideration will be given to the way in which carbon is formed and under what conditions, and also to the way in which the lubricating oil affects the power. Much will be made of the various economics which can be effected by care in this direction, and in the reduction of the wear and tear on the motor.

In the illustrations opposite, we have used the four cycle motor, which takes four strokes or two revolutions to complete the operation. The general principles however, are the same for all explosive motors, although the number of cycles varies.

"SECTION A" illustrates the position of the piston at the beginning of the stroke, during which the mixture of gasolene and air is taken through the carbureter.

It will be noted that during this stroke the admission valve is open and the exhaust valve closed. The admission valve is so arranged that it will not admit as much air into the cylinder as the piston will displace in its downward stroke; this results in the creation of a partial vacuum in the cylinder. This vacuum sucks the gasoline and air mixture through the carbureter—at the same time the lubricating oil in the cylinder will be drawn up past the piston rings into the compression chamber unless this oil is sufficiently tenacious to adhere properly to the cylinder walls.

The amount of lubricating oil which passes the rings and gets up into the explosion chamber during the stroke is greater or less according to the fit of the piston rings in the cylinder and to the character of the lubricating oil. These same conditions—that is, the fit of the piston rings and the character of the lubricating oil—affect the compression, which can be secured and maintained during the next stroke.

"SECTION B" **Compression Stroke** shows the beginning of the stroke with the piston traveling upward in the cylinder. Both valves are closed during this stroke, which is the most important cycle in the operation of the motor as far as the production of power and the general economy are concerned. As the piston travels upward it compresses the air and gas mixture in the cylinder, the degree of compression being dependent largely

Upon the close fit between the piston rings and the cylinder walls;

Upon the number of rings; and

Upon the way in which the oil will form a seal between the cylinder walls and the piston rings.

The cylinder is closed, and the only loss of compression comes through:

The fit of the valves;

Poor mechanical fit of the piston rings;

Poor and faulty lubrication.

The lubricating oil may be indirectly the cause of poor mechanical fit of the valves and piston or rings on account of hard carbon being deposited thereon.

Poor lubrication, even with a good oil will result in a loss of compression without regard to the perfect mechanical fit of the piston rings. With good lubrication and an oil of the right character, the compression can be maintained even with worn out rings and a loose piston.

"SECTION C." **Explosion Stroke.** This section shows the piston being forced down by the explosion of the mixture and the consequent expansion of the gases; as in the compression stroke, the admission and exhaust valves are closed during this stroke. The explosion of the mixture and the expansion of the gases resulting therefrom produces the power to drive the motor. Provided the carbureter is properly adjusted so that the mixture is in the right proportion for effective work, the amount of power developed from the explosion is largely dependent upon the compression secured during the second stroke; the greater the compression secured during that stroke the greater will be the initial pressure at the time of explosion, and consequently the greater the force of explosion.

If the seal between the piston rings and cylinder walls is maintained perfectly, the mixture during the second stroke will be compressed to a high degree. At the same time, during the explosion or power stroke none of the force which should be expended in driving the piston down will be lost through leakage past the piston rings.

"SECTION D." **Exhaust Stroke.** During this stroke the exhaust valves open; the admission valves being closed, the piston traveling upward forces the waste gas out of the cylinder.

This stroke completes the operation of a four-cycle engine, each cycle taking one stroke, and the whole operation taking, consequently, two revolutions.

To recapitulate—the operations are as follows:

Cycle	Stroke	Revolution	Action
First	Downward	First half of first	Intake of gas and air
Second	Upward	Second half of first	Compression
Third	Downward	First half of second	Explosion
Fourth	Upward	Second half of second	Exhaust

Outside of the efficiency of the mixture of the gas and air in the carbureter, the power developed by the motor is dependent upon compression.

The percentage of the power developed which can be used to drive the motor forward is dependent not only upon the degree of compression but also upon the way the compression is secured. In other words, in order to turn the power developed by the explosion and the expansion of the gas into useful work, it is not only necessary that the compression should be secured, but that it should be secured by proper means.

The troubles attendant upon poor compression in the cylinders are well known to most motorists. Under these conditions a motor is frequently unable to take a hill at all, and in any case the speeds must be changed in order to accomplish it. This is the case even where the same motor with good compression will not have the slightest difficulty in negotiating the same grade at top speed.

There are two ways of securing compression: First, a number of piston rings fitted very tightly in the cylinder. (This is mechanically secured compression). Second, the use of a lubricating oil of proper character so that any space between the piston rings and the cylinder walls will be taken up and entirely filled by this lubricating oil.

Mechanically Secured Compression. It is easily possible, of course, to fit the piston rings so tightly in the cylinder that there will be absolutely no escaping of the gas and perfect compression is attained. The tighter

the piston rings, however, the harder it is to move the piston up and down in the cylinder, and consequently the greater the amount of power which is lost in overcoming this difficulty. Tight piston rings are, in fact, the most effective means of reducing the available power of the motor; so much of the power goes to overcoming the friction between the piston rings and the cylinder walls that a large percentage is lost for useful work. In fact, piston rings which are held tightly against the cylinder walls offer so much resistance to the free running of the motor that it is possible to make them so tight that the motor will not turn over at all.

It is evident, therefore, that while the tight piston rings in the cylinder increase the compression they also increase the waste of power caused by the binding or pressure of the rings upon the cylinder walls.

There is, however, another very serious difficulty with this method of obtaining compression—the tighter the piston rings, the harder it is to lubricate between them and the cylinder walls. In order to work in between surfaces so close together the lubricating oil must be very thin. It is an axiom that the thinner the lubricating oil the less will be the lubricating effect and, consequently, the greater the wear and tear on the rubbing parts.

Herein lies the absurdity of attempting to obtain compression by close fitting, tight piston rings. As soon as wear takes place the surface between the piston rings and the cylinder walls becomes enlarged and the compression effect which was desired is lost by this increase in the space.

The thin oil which is necessary in order to get in between the close fitting surfaces will no longer fill up the greatly enlarged space. As a consequence of this, as soon as wear takes place:

1.—The space between the piston rings and the cylinder increases sufficiently to make it impossible to maintain the compression.

2.—The thin lubricating oil which was necessary to operate between the close surfaces is now too thin to do the work.

3.—As a consequence this oil will not fill up the enlarged space and compression is lessened.

4.—The thin oil is then drawn up by the vacuum during the first stroke, gets into the compression chamber on the top of the piston and the uppermost ring, and carbonizes.

5.—With oils made from paraffine base crudes, this carbon is hard and flinty, frequently acts like emery, increasing the wear along the cylinder walls and on the surface of the rings, so that there is a continual increase in the loss of compression and power until it becomes necessary to have new rings put in, or the cylinder repacked, bored and a new piston secured in order that somewhere near the full power of the motor can again be available.

Briefly, the mechanical difficulties in maintaining piston rings so closely fitted to the cylinder walls and lubricating the same, are so great that it is but a short time before the compression effect is lost while the unnecessary wear and tear continues.

Compression Secured by Lubricating Oil. The proper kind of lubricating oil is of such a character that it will maintain its seal between the piston rings and the cylinder walls so that there is no metal to metal contact; it will adhere sufficiently to both the cylinder walls and the piston rings to close this space so that there

is no loss of compression and no leakage past the rings. Inasmuch as there is no metal to metal contact, and the space between the piston and cylinder walls is filled with a seal of oil, there is practically no wear of the rubbing parts; as soon as wear takes place it indicates that the oil is not maintaining this seal perfectly, and, as a consequence, the compression is to some extent lost and the effective power of the motor reduced.

A further advantage is secured by the use of an oil seal between the cylinder walls and the piston rings which can be continually maintained, there is no possibility of the gas and air mixture escaping during the compression stroke. Moreover, this seal is not affected even where the piston is fitted somewhat more loosely in the cylinder than usual, as it is not dependent upon the exact mechanical fit.

Where the compression is not maintained in this way there is in a very short time a leakage of the gas and air mixture, which escapes past the piston rings into the crank case. This leakage has two detrimental effects:

1.—It decreases the efficiency of the lubricating oil in the crank case;

2.—It increases the temperature in the crank case, unduly, over normal conditions.

Both of these effects act directly against the efficiency of the motor as to its capacity.

The gasoline contained in the gas and air mixture which leaks past the piston rings where the compression is poor condenses in the crank case and mixes with the lubricating oil, making the oil lighter in body, lower in fire test and very seriously reduces the lubricating efficiency there was in it.

It is a well known fact among racing men that lubricating oil drawn from racing cars or cars that are forced, after a few hours run, looks like water, and the common expression is that it is "shot to pieces," or in other words, has broken down. As a matter of fact, the condition of the oil is simply due to the condensation of the gasoline, which comes from the mixture escaping past the piston, leaking into the crank case during the compression stroke.

Every compression stroke of the motor where there is such leakage, increases the difficulty; the greater amount of gasoline condensing in the crank case and mixing with the lubricating oil, the thinner the oil. The thinner the oil becomes the poorer the lubrication, and consequently, the greater the compression loss. The slightest loss of compression caused by this leakage acts directly and detrimentally upon the lubricating oil (which is the only means for continually maintaining compression) to such an extent as to cause still further and increased losses.

The thinner the oil, the more likely it is to be sucked up in the combustion chamber and carbonized; the higher the fire test of the oil, the greater the difficulty in consuming it during the explosion, and consequently, the greater the tendency to carbonize.

It is evident, therefore, that the greater the body of the oil and the lower the fire test, the more the available power which can be secured from the motor, and the less will be the possibility of the oil working past the piston rings into the combustion chamber and carbonizing.

The fact of the matter is that the characteristics of all paraffine base oils which form hard carbon upon combustion have made it necessary for the refiners of these oils to reduce the body as much as possible in order to get rid of the carbon forming features.

Unfortunately, however, for the American automobile owner, these light bodied oils such as have been made and are being so largely sold and

used, in their action decrease the power, the life and the economy of the motor.

In fact, it is extremely doubtful if the greatest carbon trouble would be any more costly than the losses which are constantly going on in the motors where light bodied paraffine base oil is used.

Foreign cars are lubricated almost exclusively with heavy oils; these heavy oils being available owing to the nearness of the Russian fields. There are oils in this country which are somewhat similar in characteristics and the crude from which Texaco Motor Oil is made possesses not only the characteristic heavy body which is to be found in the Russian oil, but also possesses lubricating characteristics far in advance of the oils made from Russian crudes which particularly fit it for motor lubrication.

It is undoubtedly true, and has been proved by many motor owners who have used Texaco Motor Oil, that its use will increase the available power of the motor by increasing the compression; decrease the consumption of gas and lubricating oil; increase the life by decreasing the wear-and-tear, and in other ways affect favorably to a very considerable extent the economy of the motor.

CHANGES IN LUBRICATION REQUIRED

In the last twenty years the conditions of business in practically every line of endeavor have changed to such an extent that the methods or operations have been almost entirely modified. In very few lines of industry of this kind would the equipment of machinery of twenty years ago be of value in any attempt to compete with present conditions. The mechanic, the designer, the operator and the manufacturer have all been obliged to accommodate themselves to changed conditions in order to take care of increased requirements and possibilities of business. The equipment has been altered and realtered in order that the greatest possible advantage should be taken of time and saving of labor in the production of any manufactured article.

In the same period of time a great deal of investigation has been made into the question of loss by friction, the causes of wear-and-tear on machinery and the methods to be adopted to overcome the same. The mechanical appliances and conditions of lubrication have been changed in almost all the large manufactories, power plants, etc., so that it is possible to secure lubricating conditions to-day which were unknown a few years ago. With all this rapid progress, however, very little information has been secured by the engineer, manufacturer, factory superintendent, etc., in regard to the essential qualities required in a lubricant and the way in which the conditions of work affect the lubricant to be used. This is illustrated by the fact that specifications for lubricating oil are commonly in use which have not been changed for a period of fifteen or twenty years. In regard to other materials no engineer, designer or superintendent would consider for a moment even a specification of ten years ago. The knowledge of the materials involved, the introduction of new material and the improvement in general methods have necessitated the constant rearrangement of specifications to altered conditions.

It is a curious feature of the case that plants which employ specialists in engineering whose duty it is to consider economy in methods, machinery and mechanical appliances of all kinds, including appliances for lubrication,

there has been no attempt to improve upon the methods employed in buying lubricating oil. This probably arises from the fact that the engineering chemistry of lubricating materials is an involved science and there is no extensive literature on this subject which would give the average engineer any definite information as to the qualities essential for lubricating purposes.

The conditions of refining and manufacturing oil, however, have progressed just as rapidly as all other lines of industry connected with production. The constant discovery of new fields, with new qualities and characteristics in the oil, have opened up possibilities in the production of lubricating oils which were unknown fifteen years ago and the working out of these new features has shown that the specifications formerly used for lubricating oil, and to a great extent used at present, which represent the practice of twenty years ago, do not by any means illustrate the possibilities of economy in lubrication at the present time; they are in fact as obsolete as the older methods of building a fireproof building and they should be as thoroughly disregarded.

The amount of power absorbed by the friction in machinery of all kinds and the wear-and-tear resulting from insufficient lubrication from one cause or another is sufficiently large to make the matter worthy of thorough investigation. It is somewhat astonishing, that, in some cases, even mechanical arrangements necessary for sufficient lubrication are not up to date, and oil and other lubricating materials are bought on price instead of quality, or without sufficient indication of what service the material will perform.

In the case of lubricating oil the ordinary specification, with its requirements for gravity, flash, fire, cold test and viscosity, does not in any way demonstrate the value of the material for any particular lubricating condition. It cannot be said with any degree of accuracy that an oil answering to certain limitations of the above tests will economically lubricate so as to secure a minimum amount of friction loss in any particular class of machinery. These requirements are in fact for the most part empirical, and may just as easily result in a waste as in an economy. They can be altered entirely without affecting the lubricating result. As it is the lubricating oils manufactured vary between such wide limits in the tests stated above that they are no longer subject to any specification of the kind.

The success of any lubricating system adopted in any factory, power plant or other proposition involving much moving equipment, depends upon the proper combination of the quality of oil, character of the equipment, kind of service and proper mechanical conditions. No one of these various factors which introduce the question of loss in friction and wear-and-tear can be separated from the other and decided without reference to the other conditions if a maximum of efficiency is to be secured. The best quality of oil for the purpose will not bring the results required if the lubricating system is wrong or if the mechanical conditions under which the plant is operated are not as they should be. The water used in the boilers will sometimes affect the lubrication of an engine; the size of the filter may result in the failure of a circulating system, and any one of a number of mechanical conditions may limit the success of any oil.

Specifications for oil, however good, would not correct these difficulties, and even where conditions are entirely favorable to maximum efficiency in lubrication a specification for oil will not necessarily insure the proper quality for the purpose. As a matter of

fact, it is only possible for the manufacturer of lubricating oil to guarantee maximum service where he is allowed to consider all the physical and mechanical conditions affecting the lubricating problem and determine upon the proper oils to fulfill these conditions most efficiently.

The idea, therefore, of specifying certain tests for lubricating oil is based upon an entire misconception of the conditions under which they are to be used. In the other materials with which the mechanical engineer has to work, having definite chemical composition and definite physical characteristics, it is possible to specify in a general way the limitations necessary for a particular condition. The chemical composition of oils, however, is not definite; there are variations between different oils and components not entirely understood even in the same crude. The physical characteristics are not properly defined, and the lubricating qualities are not amenable to laboratory tests which will correctly demonstrate their value.

Under these conditions it has been amply proven in many cases that much more efficient lubricating service can be secured when the question of the lubricating oils to be used is put up to the reputable manufacturer of lubricating oils, the acceptance to be based upon the efficiency of the lubricating service secured and not upon an arbitrary specification. This allows the manufacturer to take into consideration all the factors in the case; that is, the quality of the oil, the character of the mechanical appliances for lubricating, the mechanical conditions of the plant, etc., and it is possible for him to put in oils which in his experience have proved themselves suitable for the conditions shown.